REMARKS

Claims 1-14 were rejected under 35 U.S.C. §102(b) as being anticipated by US Pat. 5,941,826 (Goujon). Claim 1 describes a method for producing a spectrogram from a plurality of two or three dimensional ultrasound images depicting motion comprising delineating a region of interest (ROI) in one of the images, the ROI comprising a plurality of pixels where motion is present in the image; forming histograms of the motion data of the pixels of the ROI in a plurality of images over a plurality of defined temporal intervals; mapping the histograms to temporally discrete display elements; and displaying the display elements as a spectrogram for the ROI. An implementation of the present invention enables a spectral flow velocity display to be formed from the pixel data of a two or three dimensional image, without separate acquisition of spectral Doppler signals from a sample volume. Histograms are formed of the motion data of the pixels (*e.g.*, color Doppler data) over a sequence of image frames and each histogram is used as a velocity distribution line in a spectral display.

Goujon is not doing this. Goujon is trying to do Doppler angle correction. He does this by plotting radial lines out from a point in the middle of a blood vessel as shown in his Fig. 3. He then forms a histogram of the gray levels (not the motion data) along each line to find the grayscale threshold T_{i-1} which indicates the grayscale level of the vessel wall pixels. He then uses this level to examine the pixels along each line and find the point of the vessel wall along each line where the grayscale level begins to exceed the threshold. These points are analytically connected to form a line indicating the side of the vessel wall, and the slope of this line is measured and used to determine the flow direction (flow being essentially parallel to the vessel wall) and used for Doppler angle correction, which is the correction of Doppler estimates in consideration of flow which is across (rather than in line with) the Doppler beam direction. Goujon's technique is nicely summarized in the summary of the invention in columns 1-2 of

the Goujon patent.

Goujon then uses his angle correction technique to correct the Doppler estimation in the four types of ultrasonic Doppler applications listed in col. 5, lines 51-65. Type C in the list is a spectral Doppler display. Goujon summarizes the production of a spectral Doppler display in column 6, lines 31-59. He contrasts spectral Doppler with a 2D grayscale or colorflow image by pointing out that the standard spectral Doppler technique "inject(s) the successive pulses at the same location of the medium." The echoes returned from this one location over time are processed with one of several estimation methods (*e.g.*, an FFT as explained by Mo et al.) to produce a histogram of velocity estimates which is strictly a function of time (as the spatial location never varies.) Each histogram is a line of one instant in time of the Doppler spectrum in a spectral Doppler display. This is the traditional way in which spectral Doppler is done. Goujon then proposes his angle correction technique for correcting the value of the Doppler angle used for the spectral Doppler estimation in the Doppler equation $v = c\ df/(4P\ fT \cos(DA))$, where DA is the Doppler angle and df is the Doppler shift (see column 6, line 6).

The echo data used for the spectral Doppler display is determined by aiming a line over an ultrasound image and marking a point along a line called a "sample volume." The sample volume sets a range gate that the system uses repetitively to acquire echoes at the same time after each transmitted pulse, thereby ensuring that every echo is returned from the same point in the body (as long as the probe is held steady). A series of these echoes are processed to estimate the Doppler phase or frequency shift df using the Doppler equation stated by Goujon in column 6, line 6. In the claimed invention a spectrogram is produced from ultrasound image data, not the range-gated data from the same location as is done in Goujon. In the claimed invention, a region of interest comprising a plurality of pixels is delineated, and the motion data of those pixels is used to form a histogram. For

instance, the color Doppler data of a group of pixels can be selected as shown in the example of Fig. 2 of the present application to form a histogram of this data as shown in Fig. 4. The histogram is converted to a column of values as shown in Fig. 5, then used as one line 124 of a spectral display as shown in Fig. 6. There is no need to aim a line over the image as is done in the standard spectral Doppler technique, and no computation of the Doppler phase or frequency shift, as that characteristic is inherent in the Doppler data of the pixels. A spectral display can be created directly from the color velocity pixel values of a colorflow image, which is not shown or suggested by Goujon, whose techniques and teachings do not use the delineating and forming steps of the claimed invention.

Amended Claim 6 describes a method for displaying the distribution of a motion characteristic occurring at a region of interest in a two or three dimensional ultrasound image of the body comprising acquiring a sequence of spatially dimensioned ultrasound images in which a motion characteristic is displayed; delineating a region of interest (ROI) in one of the images where motion is present in the image; processing the motion data from image points of the delineated ROI to determine the distribution of a motion characteristic as a function of time; and displaying the distribution of the motion characteristic in a spectral display as a function of time. The standard spectral Doppler technique of Goujon does not show or suggest processing the motion data from image points of a delineated ROI to determine the motion characteristics as a function of time. Motion data from delineated image points of an ROI of an image is not used or suggested by Goujon.

For these reasons it is respectfully submitted that Goujon cannot anticipate Claims 1 and 6 or their dependent Claims 2-5 and 7-14.

Claims 15-21 were rejected under 35 U.S.C. §103(a) as being unpatentable over Goujon in view of YS Pat. 6,142,943 (Mo et al.)

Amended Claim 15 describes an ultrasonic diagnostic imaging system which provides motion information concerning a location in the body comprising an ultrasound probe which transmits ultrasonic energy and receives ultrasonic echo signals in response; a beamformer coupled to the probe which forms coherent echo signals from spatial locations in the body; a motion processor responsive to the spatial echo signals which produces image data depicting motion; a display responsive to the image data which produces two or three dimensional images depicting motion on a spatial basis; a user control by which a user can delineate a region of interest in an image depicting motion; a motion characteristic processor, responsive to image signals depicting motion of a region of interest which computes the distribution of a motion characteristic as a function of time, wherein the display displays the distribution of a motion characteristic in a spectral display as a function of time for a delineated region of interest. Mo et al. are concerned with optimizing a spectral Doppler display so that the display will adequately encompass the dynamic range of the spectral display and will not alias, or wrap around. The spectral Doppler display that Mo et al. are optimizing is produced in the conventional way, as described from col. 3, line 30 through col. 4, line 10, using Doppler signals produced by repeatedly firing a transducer array at the same location in the patient. Mo et al. do not show or suggest producing a spectral Doppler display from the motion information of the image of signals of a region of interest in a two or three dimensional image. Thus Mo et al., like Goujon, do not show or suggest the motion characteristic processor recited in Claim 15. Accordingly it is respectfully submitted that Claim 15 and its dependent claims are patentable over the combination of Goujon and Mo et al.

In view of the foregoing amendment and remarks, it is respectfully submitted that Claims 1-14 are not anticipated by Goujon and that Claims 15-21 are patentable over Goujon and Mo et al. Accordingly it is respectfully requested that the rejection of

Claim 1-14 under 35 U.S.C. §102(b) and of Claims 15-21 under 35 U.S.C. §103(a) be withdrawn.

In light of the foregoing amendment and remarks, it is respectfully submitted that this application is now in condition for allowance. Favorable reconsideration is respectfully requested.

Respectfully submitted,

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